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Dataplot 70:
Fortran-Callable Plotting Routines

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Carol V. Young and
Philip G. Stein

Institute for Basic Standards
National Bureau of Standards
Washington, D.C. 20234

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DATAPLOT 70:
FORTRAN-CALLABLE PLOTTING ROUTINES

by

Carol V. Young
and
Philip G. Stein

Office of Measurement Services
Institute for Basic Standards
National Bureau of Standards

A description is given of Dataplot 70, a program which enables plotting
(1) lines between pairs of X-Y coordinates, and (2) a string of ASCII
characters at a given X-Y coordinate on the electrostatic printer/plotter.
Detailed instructions are provided enabling the user to (1) convert data
to plotter format, (2) draw axis, (3) label axis, (4) scale data,
(5) handle arrays, (6) produce symbols at end points, and (7) offset
the origin. Hardware and software requirements as well as loading and
operating instructions are given.

A sample FORTRAN calling program is included and each instruction is
explained in detail. The output of the calling program is shown. Error
messages produced by Dataplot 70 are explained.

Key Words: Digital plotter; graph; graphics; minicomputer; plotter

1. INTRODUCTION

1.1 General

The Dataplot 70 package enables plotting of (1) lines between pairs of X-Y coordinates and (2) a string of ASCII characters at a given X-Y coordinate, on an electrostatic printer/plotter. Provisions are made to draw and label axes, scale data, handle arrays (sets of X,Y locations of data points), produce symbols at end-points and offset the origin.

The package consists of two parts: (1) a special run-time library for data formatting made up of 5 FORTRAN and 6 ASSEMBLER subroutines, and (2) a load module containing the assembler language plotter and driving routines.

The user writes a FORTRAN program to call the data formatting subroutines. These convert his floating point data coordinates and ASCII labels and titles to properly formatted data for input to the plotter routines. This formatted data is output to a mass storage device.

The plotter routines will read this file from the mass storage device, sort and process the data, and produce a plot on the electrostatic printer/plotter.

Paper tape punch and reader can be substituted for the mass-storage device.

Files to be input directly into the plotter can be prepared on other computers but must be in the proper format (see Section 3.2). The plotter is capable of accepting files which are unsorted, or are sorted in either ascending or descending order.

1.2 Hardware Requirements

The hardware required to support the Dataplot 70 consists of:

A. Any one of Interdata models 5, 70, 80, 85, 74, 7/16, 7/32 with high speed ALU of software supports for floating point.

B. 8 KB of core (minimum)

C. Some binary data storage peripheral device (paper tape reader and punch, disc, tape, or cassette)

D. Operators console to print error messages

E. Varian Statos 31 plotter with Varian interface to Interdata I/O multiplexor bus

1.3 Software Requirements

BOSS or other Interdata operating system, modified to allow user direct I/O as described in section 3.5 is required to support the Dataplot 70 package. The package is not designed for use in a real-time environment.

1.4 Axis of Plot

The origin of the plot is in the lower left-hand corner of the plot area. The X direction is in the direction of the paper movement. The Y direction is across the width of the paper. See Figure 1.4.
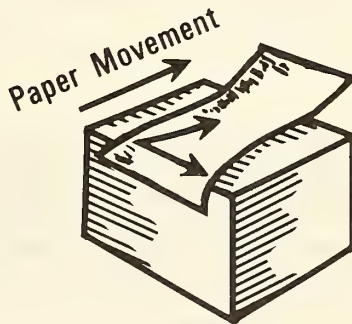
FIGURE 1.4.

A plotter unit of X corresponds to one step (0.01") of paper movement in the printer. A plotter unit of Y corresponds to 0.01" across the page and represents the smallest stylus interval.

2. DATA FORMATTING

2.1 General

A user's FORTRAN program first reads in or generates data to be plotted. Next, it calls the data formatting subroutines. These process the user's data producing data in the proper format for input to the plotter routines. The first call must be "CALL OPEN" and the last call must be "CALL CLOSE."

Each set of formatted data (vector or character) produced by the data formatting subroutines requires 8 bytes (see Section 3.2). The subroutines use a 512 byte buffer which holds 64 sets of formatted data. The subroutines process 64 sets of data and then output the entire buffer as one record to a mass storage device. This is repeated until all the data has been processed and output.

2.2 Data Format

All X and Y coordinate data are input to the data formatting subroutines as single precision floating point numbers representing displacement (in inches) from the origin. The subroutines output the data to a mass storage device as positive integers (15 bits) in plotter units (100 plotter units/inch).

2.3 Range of Data

The value of the X coordinate must be positive. The value of the Y coordinate must be positive and less than 14.08 inches. If any of the floating point coordinate data are outside these ranges, then either the data must be scaled, (see Section 2.4.8) the origin offset, (see Section 2.4.2) or both.

2.4 Data Formatting Subroutines

2.4.1 OPEN

Subroutine OPEN initializes pointers and rewinds the mass storage device.

Calling Sequence: CALL OPEN

2.4.2 ORIG

ORIG offsets the origin.

Calling Sequence: CALL ORIG (X,Y)

Where:

X   Is the distance (in inches) along the X axis by
        which the new (relative) origin will be offset
        from the old. (Floating point)

Y   Is the distance (in inches) along the y axis by
        which the new (relative) origin will be offset
        from the old. (Floating point)

Each coordinate processed by the data formatting sub-
routine after this call will be relative to the new
origin.

2.4.3 VECT

VECT generates the vector end point data which, when
input to the plotter routines will draw a line
between the given pairs of X-Y coordinates.

Calling Sequence: CALL VECT (X1, Y1, X2, Y2)

Where X1, Y1, X2, Y2 are single precision floating
pointing numbers representing inches of displacement
from the origin.

Provision is made for plotting a continuous series
of points. The second X-Y coordinate from the most
recent VECT call are saved as continuation points. If
in a VECT call X1 = 999. and Y1 = 999., the current
continuation points are used as X1 and Y1. The
initial continuation point can be set by the subroutine
CURR (see Section 2.4.4).

2.4.4 CURR

CURR initializes the beginning point when plotting
a continuous series of points (see VECT above).

Calling Sequence: CALL CURR (X,Y)

Where X and Y are single precision floating point
numbers representing distance in inches from the origin.

Example:

```
CALL CURR (X(1),Y(1))
DO 10 I = 2,N
10 CALL VECT (999., 999., X(I),Y(I))
```

2.4.5 CHAR

The subroutine CHAR generates the code which when
input to the plotter writes the ASCII string starting
at the given X-Y coordinate. The characters are
software generated dot matrix characters in two sizes:
small (0.05" x 0.07") and large (0.10" x 0.14") and two
orientations: Upright (0 degrees rotated from the
Y axis) and sideways (-90 degrees rotated from the Y
axis). The standard spacing for small characters is
0.03 inches and for large characters is 0.04 inches.

Calling Sequence: CALL CHAR (X, Y, STRING, ISAOR,
                    NCHAR, ISPAC)

Parameters:

X, Y   X and Y coordinates (in inches) of the first
          letter (upper left-hand corner of an upright
          character, lower left-hand corner of a
          sideways character). (Floating point)

STRING   Address of the first word containing the ASCII
          character string to be plotted. It can be given
          as a variable name, or as per the example below.

ISAOR   Size and orientation:

          0 = small, 0 degrees rotation from Y direction
          1 = small, -90 degrees rotation from Y direction
          2 = large, 0 degrees rotation from Y direction
          3 = large, -90 degrees rotation from Y direction
             (Integer)

NCHAR   The total number of characters to be plotted in
          the string. (Integer)

ISPAC   Spacing constant in styli or scans from the
          starting coordinate of the previous character.

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A negative number causes default standard
spacing. (Integer)

Example: CALL CHAR (1.0, 1.0, 6HSTATOS, 2,6, -1)

2.4.6 SYMBOL

SYMBOL generates code which, when input to the plotter
routines will produce a symbol centered at the given
X-Y coordinate.

Calling Sequence: CALL SYMBOL (X, Y, IEQ)

X, Y   Single precision floating point coordinates

IEQ   Positive integer designating symbol to be
          produced. (1, 2, 3, 4, or 5.)

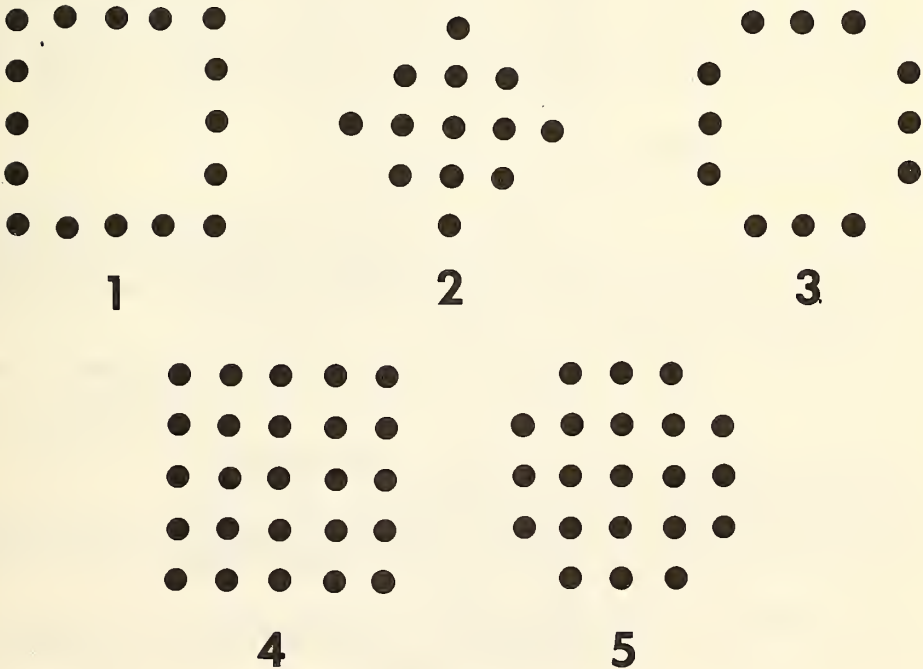The types of symbols indicated by these integers are
shown in Figure 2.1.

FIGURE 2.1.

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2.4.7   NUMBER

NUMBER converts single precision floating point
numbers to ASCII code and generates code which when
input to the plotter routines will print the number
starting at the given X-Y coordinate.

Calling Sequence: CALL NUMBER (X, Y, FPN, ISAOR, NDEC)

This call will plot the floating point, single precision
number FPN at the point X, Y.

Parameters:

X, Y   Coordinates (in inches) of the first number in
         the string (upper left-hand corner of
         upright number, lower left-hand corner
         of sideways number). (Floating point)

FPN   Floating point number to be plotted. If negative,
         will be prefixed with a minus sign. Leading
         zeros will be suppressed, except the zero to the
         left of the decimal point. The floating point
         number is rounded by adding 5 to the digit to
         the right of the last digit to be plotted, then
         truncating the result. (Floating point)

ISAOR   Size and Orientation:

         0 = small, 0 degrees rotation from Y direction
         1 = small, -90 degrees rotation from Y direction
         2 = large, 0 degrees rotation from Y direction
         3 = large, -90 degrees rotation from Y direction
             (Integer)

NDEC   Number of decimal places to be plotted to the
         right of the decimal point. (Integer)

         If $0 < NDEC \leq 4$, NDEC digits will be plotted
         to the right of the decimal.

         If NDEC = 0, only the decimal will be plotted to
         the right of the integer portion of the floating
         point number.

         If NDEC = -1, the decimal point is omitted along
         with the fraction.

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If NDEC < -1, NDEC-1 numbers are truncated from the right side of the integer portion of the floating point number. The number of characters plotted, regardless of NDEC, is always greater than or equal to 1.

If NDEC > 4, only the first four digits will have any meaning. This subroutine will handle floating point numbers whose integer part is less than 32768 and will write up to 4 digits to the right of the decimal point.

2.4.8 SCALE

This subroutine calculates a scale factor and a displacement factor.

Calling Sequence: CALL SCALE (ARR,NPTS,PGSZ,INC)

ARR The name of the (floating point) array to be scaled.

NPTS The number of points to be scaled in the array. Normally, all points are scaled. (Integer)

PGSZ The size of the page (linear interval in inches) within which the data must fall. (Floating point)

INC The increment at which the array is to be sampled. (Integer)

The calling FORTRAN program dimensions the array to have NPTS + 2 dimensions. The SCALE subroutine stores the displacement factor in ARR (NPTS+1) and the scale factor as ARR (NPTS+2). The scale factor and displacement factor are used by the subroutine DATA. (See below.)

2.4.9 DATA

The subroutine DATA with one call takes two arrays of equal size, one containing the X values and the second containing the corresponding Y values and produces the formatted data which when input to the plotter routines will plot each point.

Calling Sequence: CALL DATA (XARR, YARR, NPTS, INC,
        LTY, IEQ)

Parameters:

XARR   The name of the array from which X values are
        to be extracted. (Floating point)

YARR   The name of the array from which the Y values
        are to be extracted. (Floating point)

NPTS   The number of data points to be plotted from
        each array to the end of the array. (Integer)

INC   The increment at which the arrays are to be
        sampled. INC = 1 means every X, Y pair is plotted;
        INC = 2 means every other pair, etc. (Integer)

LTY   Indicates the type of line desired.
        LTY<0: A symbol will be plotted at each selected
                point, but no lines will connect the
                symbols.
        LTY=0: A line will be drawn connecting each
                selected point. No symbols will be
                drawn.
        LTY>0: A symbol will be plotted at each
                selected point and a line will connect
                all symbols.

IEQ   Positive integer designating symbol to be produced
        (1, 2, 3, 4, or 5). (Integer) (See Figure
        2.1.)

If LTY = 0, IEQ has no meaning.

Prior to the call, the two arrays must be dimensioned
to provide two extra locations at the end of each array.
These locations must contain the displacement and the
scale factor in that order.

The subroutine DATA will use these factors to operate
on each floating point datum as follows:

$$X' = \frac{X(I) - Displacement}{Scale\ Factor}$$

OR

$$X' = \frac{X(I) - X(NPTS+1)}{X(NPTS+2)}$$

The subroutine SCALE (see above) will calculate these
factors and store them in the proper locations. How-
ever, note that the scale factor for the X array and
the scale factor for the Y array are independent of
each other. The programmer can calculate these
factors and store them in the proper location. Care
should be taken with the sign of the displacement since
it is a value to be <u>subtracted</u> from each datum.

2.4.10 AXIS

Subroutine AXIS produces an axis on the plot with tic
marks every inch, an axis label and number labels for
each tic mark.

Calling Sequence: CALL AXIS (X, Y, AXLH, IDIR, BCD,
                    NCHAR, VLO, SF)

Parameters:

X, Y   The starting point on the page of the axis to
        be drawn. (Floating point)

AXLH   The length of the axis in inches. The value
        given will be truncated to the next smallest
        integer value. (Floating point)

IDIR   Axis direction. Zero for X direction. Non-zero
        for Y direction. (Integer)

BCD   The first word address of a character string
        to be plotted as a label for the axis. If there
        is no label, use a dummy space.

NCHAR   NCHAR is the number of letters contained in the
        character string to be plotted as a title.
        (Integer)

        If NCHAR > 0, the title, tic marks, and interval
        labels will be plotted to the left of the
        vertical axis and above the horizontal axis.

        If NCHAR < 0, the title, tic marks and interval
        labels will be plotted to the right of the
        vertical axis and below the horizontal axis.

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VLO   The number to be plotted at the starting point
            of the axis. By making VLO = ARR(NPTS+1),
            the axis and data will have the same
            starting point. (Floating point)

SF   The scale factor (units/inch) to be used in
            labeling the 1 inch intervals. By making SF =
            ARR(NPTS+2) (see Scale routine), the axis and
            data will have the same scale factor.
            (Floating point)

NOTES:

1. The intervals labels will be scaled by powers of 10
    if they are too large or small to fit into 2 decimal
    place accuracy. Thus, assuming a scale factor of
    1000./inch, 12000. would be printed 12.00 on the
    interval tic mark, but a note would be added to
    the axis label: "$*10^3$."

2. The SCALE routine should be used prior to using AXIS
    if SF = ARR(NPTS+2) and VLO = ARR(NPTS+1).

2.4.11 CLOSE

The subroutine CLOSE will output the last partial record
which contains the software end-of-file mark and will
rewind the mass storage device.

Calling Sequence: CALL CLOSE

This call must be the last statement in each data genera-
tion FORTRAN calling program.

2.5 Sample FORTRAN Calling Program

See Figure 2.2.

2.5.1 Problem Statement: Produce a plot of X = SIN Y as Y
       varies from 0 to 8π.

2.5.2 Program Listing

```
DIMENSION X(723),Y(723)
DATA X(722),X(723)/-1.,.5/
J=0
DO 1 I=1,1441,2
J=J+1
```

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```
      Y(J)=(FLOAT(I-1))*3.14159/180.
    1 X(J)=SIN(Y(J))
      CALL OPEN
      CALL ORIG(1.,.9)
      CALL SCALE(Y,721,13.,1)
      CALL DATA(X,Y,721,1,0,1)
      CALL AXIS(0.,0.,4.,0,6HSIN(Y),6,-1.,X(723))
      CALL AXIS (2., 0., 12., 1, 1H , -1, Y(722), Y(723))
      CALL CHAR(-.5,6.5,1HY,2,1,-1)
      CALL CLOSE
      STOP
      END
```

2.5.3 Explanation of Calls

DATA X(722),X(723)/-1.,.5/
Set up the X displacement and the X scale factor.
The displacement of -1 units is necessary to insure all
X values output for plotter will be positive. The scale
factor of 1/2 units/inch is arbitrary.

CALL OPEN
Initializing routine

CALL ORIG(1.,.9)
Offsets the origin by 1 inch in the X direction and 0.9
inches in the Y direction. This allows room to the left
of the plot and below the plot for axis labels. All
data processed will be with respect to this new origin.

CALL SCALE(Y,721,13.,1)
Scales all 721 values in the Y array to fall between
0 and 13 inches by calculating a displacement and scale
factor and storing these values in Y(722) and Y(723)
respectfully. The Y values vary from 0 to about 25.1
yielding a scale factor of 2 units/inch and a displacement
of zero.

CALL DATA(X,Y,721,1,0,1)
Processes each value in each array by subtracting the
displacement and dividing by the scale factor, and then
generates and outputs the formatted data for input to
the plotter routines for each of the 721 points.

CALL AXIS (0., 0., 4., 0, 6H SIN(Y), 6, -1., X(723))
Generates and outputs formatted data for the plotter routines
to draw the X axis tic marks, axis label, and interval
labels. The axis is to be started at the relative

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origin (0.,0.) to be 4 inches long, and to be labeled
SIN(Y). The number of characters argument is positive
causing the labeling to be done to the left of the axis.
The label for the starting point of the axis is -1. and
the same scale factor is used as is used in the DATA
call.

CALL AXIS (2.,0.,13.,1,1H ,-1,Y(722), Y(723))
Generates and outputs formatted data for the plotter
routines to draw the Y axis, tic marks, and the interval
labels. The axis is started at the origin of the sine
plot. Since the displacement is -1 units in the X direction
and the scale factor is 1/2 unit/inch, the origin of the
sine plot is 2 inches above the relative origin of the
plot area. In the Y direction there is no difference
between the sine plot origin and the relative origin
of the plot area since the Y displacement, Y(722), is zero.

No axis label is desired since the axis subroutine would
print the label close to the axis which in this case
would interfere with the graph. In some cases when
no label is desired, the "number of characters" argument
can equal zero and the ASCII argument can be a dummy
argument. However in this case, in order to print the
tic marks and the interval labels below the axis, the
"number of characters" argument must be negative.
A label of one ASCII blank is therefore called for with
the "number of characters" argument being -1.

The scale factor is the same as used in the DATA call.

CALL CHAR (-.5, 6.5, 1HY, 2, 1, -1)

Produced a label for the Y axis below the graph
area. Since the relative origin of the graph area
in the X direction is offset one inch above the
origin of the plot area, the X coordinate Y -.5
will position the label 1/2 inch below the graph
area but will fall within the plot area.

CALL CLOSE

Outputs the last partial buffer to the mass storage
device.

SAMPLE OUTPUT
FIGURE 2.2.

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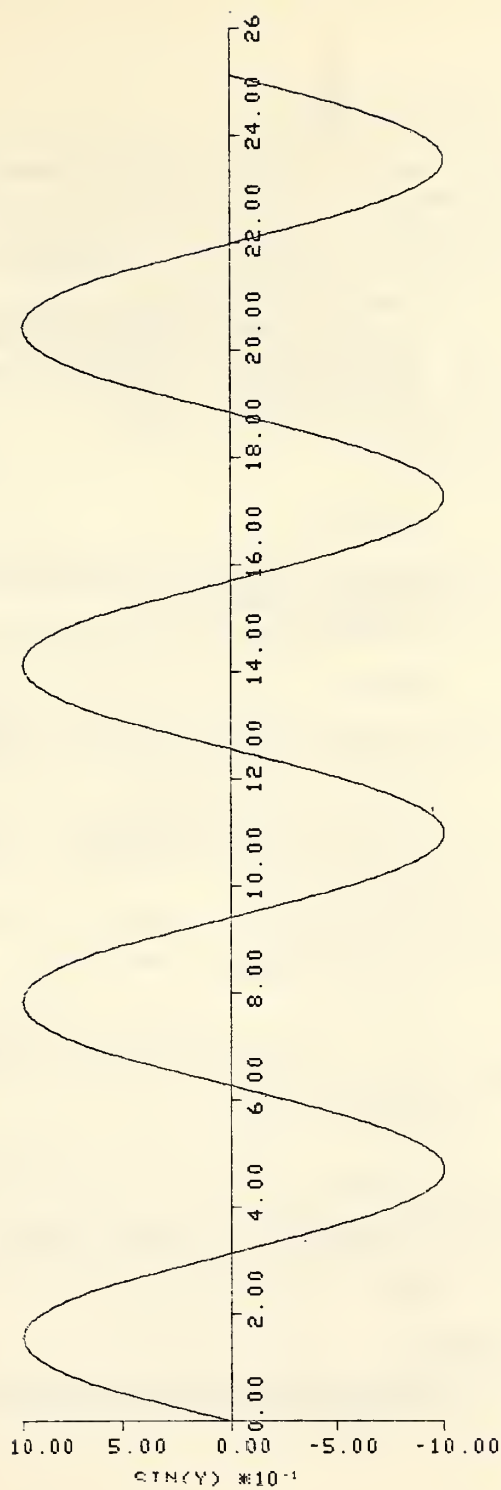
2.6 Loading Procedures

The data formatting calling program is loaded with the OS library loader.

1. Compile the FORTRAN calling program.
2. Assign logical units to
   a. FORTRAN calling program (object) (LU)
   b. User's subroutine (object) if any (LU')
   c. Special run time library (LU'')
   d. FORTRAN run-time library (LU''')
3. Load the OS library loader
4. Start loader
5. Set bias

      BIAS bbbb

   where bbbb is the desired program origin expressed in hexadecimal notation.
6. Load FORTRAN calling program (object)

      LOAD LU

7. Link FORTRAN user subroutines, if any

      LINK LU' (as required)

8. Edit special run-time library

      EDIT LU''

9. Edit the FORTRAN run-time library

      EDIT LU'''

10. Produce a memory map

      MAP LU

    Memory map is output on logical unit LU.

11. Return control to operating system.

      END

2.7 Execution

1. Assign logical unit A to a scratch area on a

mass storage device or to a paper tape punch
device.

NOTE: Operating system must be generated to
include at least 12 logical units to allow logical
unit A to be used.

2. Start at the program origin.

The program will output the unsorted data formatted
for input to the plotter routines on logical unit A.

2.8 Error Messages

2.8.1 I/O Errors

These messages are produced if an I/O error is
encountered during an attempt to output to logical
unit A. The xxxx is the status byte.

1. DEVICE UNAVAILABLE xxxx
    Cause: Device not on line
    Program response: Pause
    Operator response: Turn on device, type CONTINUE

2. BEGIN/END OF DEVICE xxxx
    Cause: End-of-medium encountered
    Program Response: Terminate run and return control
                       to operating system
    Operator response: Assign a larger scratch area
                        to logical unit A and restart
                        program at origin.

3. I/O ERROR xxxx
    Cause: Unrecoverable error
    Program response: Terminate run and return control
                       to operating system

2.8.2 Data Errors

A data error message is produced when the value of a
floating point coordinate is outside the range handled
by the data formatting subroutines

DATA ERROR xxxx

The value of xxxx indicates which coordinate and in
which subroutine the error occurred.

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ERROR MESSAGE	COORDINATE	SUBROUTINE	RESPONSE
Data Error 0103	X	CHAR	Data ignored*
Data Error 0104	Y	CHAR	Data ignored*
Data Error 0203	X	VECT	Data ignored*
Data Error 0204	Y	VECT	Data ignored*
Data Error 0303	X	CURR	Program terminated. Control returned to operating system.
Data Error 0304	Y	CURR	Program terminated. Control returned to operating system.
Data Error 0403	X	ORIG	Program terminated. Control returned to operating system.
Data Error 0404	Y	ORIG	Program terminated. Control returned to operating system.

* After 20 data error messages from either CHAR
  or VECT, the program is terminated and control
  is returned to the operating system. This
  feature can be altered by changing the maximum
  error count. The constant is at location X'28'
  relative to the entry point OPEN.

3.   PLOTTER ROUTINES

   3.1 General

      The plotter routines, started at the origin will:

      1. Calculate and request as much core as is
          available for use as the data buffer.
      2. Read the entire data file from the mass
          storage device into the data buffer.
      3. Sort the entire file in descending order.
      4. Output the entire sorted file to the mass
          storage device.
      5. Read the sorted data from the mass storage
          device, one record at a time.
      6. Convert from vector format to raster format.
      7. Output the raster data to the printer/plotter
          through driver routines.
      8. Read and process consecutive records until
          end-of-file is reached.

9. Release buffer storage and return control to
    the operating system.

3.2 Data Formats

Data to be read by the plotter routines must be in either
Vector Format or Character Format. Each set of data are
contained in 8 bytes.

3.2.1 Vector

A set of vector data (see Figure 3.1) consists
of end point X and Y co-ordinates represented as
positive integers in plotter units (100 plotter
units per inch).

$\longleftarrow$ ——— 16 bits ——— $\longrightarrow$
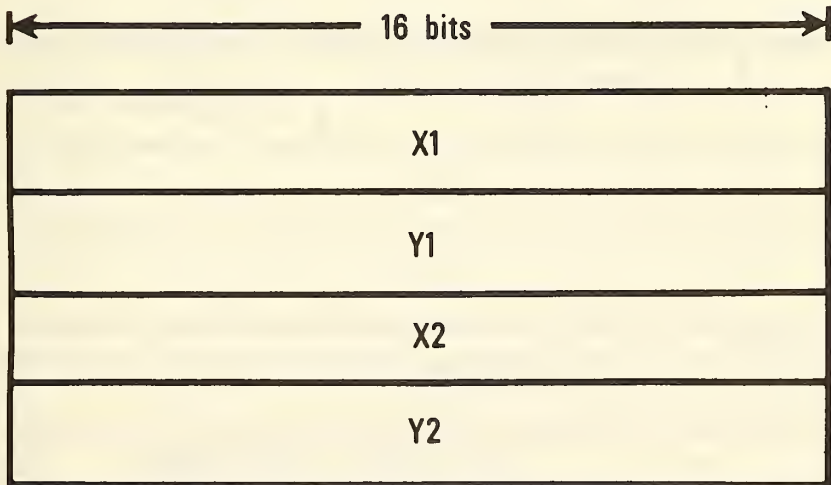
X1
Y1
X2
Y2

FIGURE 3.1.

The plotter routines will sort in descending
order and therefore X1 will be greater or equal
to X2. This is also true if data files are
generated on other computers and presorted in
descending order. However, if the files are
presorted in ascending order, then X2 must be
greater or equal to X1.

3.2.2   Characters

Character format (see Figure 3.2) consists of
X and Y co-ordinates as positive integers in
plotter units (100 plotter units per inch), a
code indicating that the data is character data,
the ASCII code of the character, and information
indicating the size and orientation of the
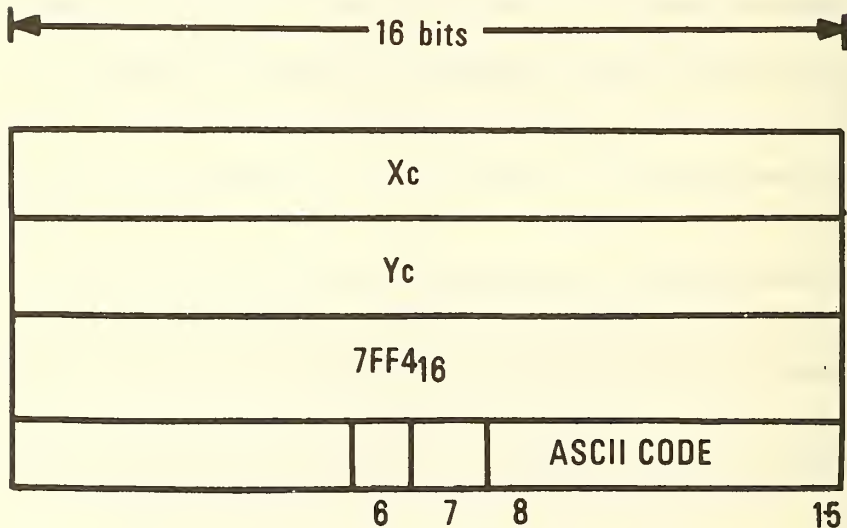character.

FIGURE 3.2.

Bit number 6 of the fourth word determines the size of the character:

    BIT 6 = 0 for small characters
    BIT 6 = 1 for large characters

Bit number 7 of the fourth word determines the orientation of the character:

    BIT 7 = 0 for upright characters
    BIT 7 = 1 for sideways characters

The X and Y coordinate refer to the upper left-hand corner of an upright character and the lower left-hand corner of a sideways character as shown in Figure 3.3
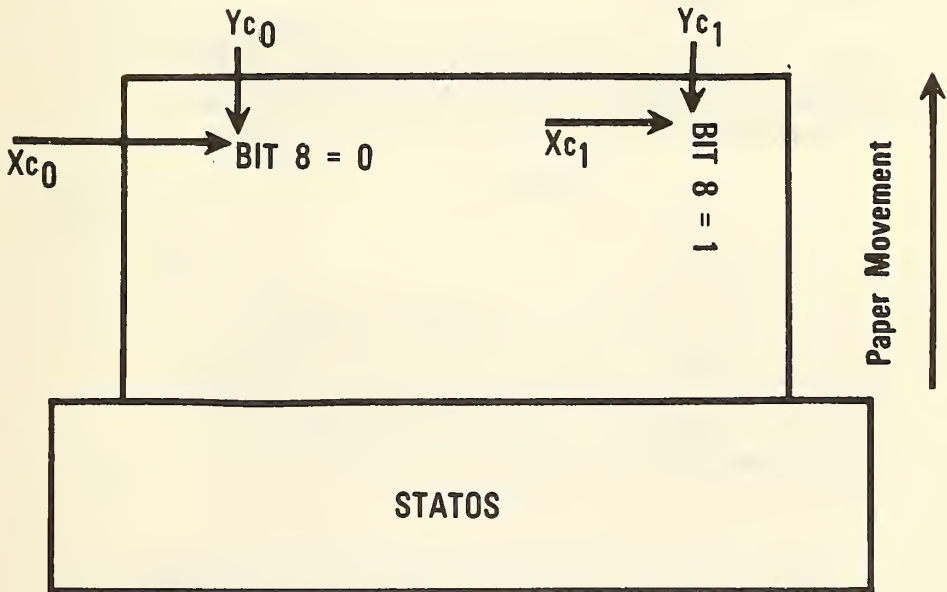

FIGURE 3.3.

C_0 in Fig. 3.3 refers to bit 7 = 0 in Fig. 3.2.
C_1 in Fig. 3.3 refers to bit 7 = 1 in Fig. 3.2.

3.3 Size of Data Buffer

Each record is 512 bytes long. The number of records, N, that can be handled is defined as

$$N = \text{integer} \frac{(\text{available core} - 2)}{512} \text{ bytes}$$

Each set of data (vectors or characters) require 8 bytes (see Section 3.2). The file is terminated with a software end-of-file mark (X'7FFF'). The amount of data that can be contained in the buffer for the sort is 64*N sets. Data in excess of this amount will be lost. The number of records of sorted data output to a mass storage device will equal the number of records read except when the buffer is full in which case N+1 records are output.

There is no limit to the number of records that can be read in for conversion from vector to raster format. However, the number of sets which can be handled on any given plotted line is

$$\frac{512(N-1) + 2}{12}$$

3.4 SORT

The sort routine will sort the entire file on the first halfword of each 4 halfword sets of data in descending order. The sort is therefore on X for character sets and on X1 for vector sets. The vector data was formatted during the data formatting subroutines so that $X1 \geq X2$ in each set.

3.5 Operating Considerations

The plotter reads the formatted input data produced (for example) by the data formatting routines. It sorts the data and writes it out again. It then rereads the data one records at a time for plotting. All of these operations are done using supervisor calls compatible with Interdata operating systems (see sections 3.7.1 and 3.7.2).

Communications with the printer/plotter are done using stand-
alone drivers as supplied by the manufacturer and modified at
NBS. As such, the protect mode of the CPU as enabled by the
OS prevents this communication.

To remedy this deficiency, it is necessary to turn off the
protect bit.

3.5.1 OS MODIFICATION (BOSS) METHOD

Change the contents of location UPSW from X'3D00'
to X'3C00'. This modifies the user PSW provided
by the START command so that protect mode is
disabled.

Similar procedures will work for other OS but will
cause difficulty in a real-time environment. Use of
this package implies dedication of the CPU to the
Statos 31 for the duration of the run.

3.5.2 PROGRAM METHOD

The following program will turn off the protect bit
and jump to the plotter routines. If an SVC 0 is used
anywhere else in the system, care must be taken to
restore it.

```
PROFF   LH 0,X'9A'                          Get new PSW for SVC's
        NHI 0,X'FEFF'                       Kill protect bit
        STH 0,X'9A'                         Put new PSW back
        LHI 0, (absolute address of         Get start addr. of plotter
                origin of plotter)
        STH 0,X'9C'                         Put in new PSW (loc) for SVC 0
        SVC 0,0                             Do the SVC 0
```

This program will disable protect mode, but the OS
will restore it the next time the START command is
executed unless the modification of section 3.5.1 has
been made.

3.6 Procedure for Loading

The load-module is loaded with the OS resident loader.
(This example is for BOSS.)

BIAS xxxx

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where xxxx is the desired program origin expressed in hexadecimal notation.

LOAD pa

where pa is the physical address of the device from which the program is to be loaded.

3.7 Execution

3.7.1 With Mass Storage Device

1. Assign logical unit A to the input file.
2. Assign logical unit 9 to a scratch area where the sorted data can be written.
3. Turn on the Varian printer/plotter
4. Start plotter routines at origin.

The program will read the entire data file from logical unit A, sort the data, write the sorted file on logical unit 9, read and process consecutive records from logical unit 9, position paper in printer to top of page, output raster data to the plotter and return control to the operating system.

3.7.2 With Paper Tape Device

1. Assign logical unit A to the paper tape punch/reader.
2. Assign logical unit 9 to the paper tape punch/reader.
3. Load input tape into the paper tape reader.
4. Turn on printer/plotter, paper tape reader and paper tape punch.
5. Start plotter routines at origin.

The program will read the input tape, sort the data and output the sorted data to the paper tape punch device.

6. Turn off the paper tape reader as soon as the read operation is complete and before the punch operation is complete.

The program will produce the messages:

    DEVICE UNAVAILABLE xxxx
    PAUSE

7. Load the tape of sorted data into the paper
    tape reader, turn on reader.

8. Type CONTINUE

The program will read and process consecutive records
from this tape, output raster data to the plotter and
return control to the operating system.

3.7.3 SORTED FILES

1. Assign logical unit 9 to the sorted file.

2. Start at ORIGIN + 8

If the file was sorted on another computer in ascending
order, the program will print a message to the operator
indicating an ascending sort and will plot the comple-
ment of the data.

3.8 Error Messages

3.8.1 I/O Errors

These messages are produced if an I/O error is encountered
during the read or the write operations.

xxxx is the status byte.

1. DEVICE UNAVAILABLE xxxx
    (See Section 2.8.1)

2. BEGIN/END OF DEVICE xxxx
    (See Section 2.8.1)

3. I/O ERROR xxxx
    (See Section 2.8.1)

4. EOF ENCOUNTERED IN VECTOR FILE xxxx
    Cause: A file mark has been read during binary
            input.
    Program response: Terminate run and return control
                       to operating system.

3.8.2 Plot Error

1. VECTOR FILE TOO LARGE
    Cause: Data file input from logical unit A is
            too large.
    Program response: Continues to process all data
                       in buffer. Additional data is
                       lost.

2. CURRENT VECTOR FILE OVERFLOW
    Cause: The number of sets of data to be plotted
            on the current line is too large.
    Program response: Continues to process all data
                       in buffer. Additional sets of
                       data for that current line are lost.

3. PLOT ERROR xxxx
    where xxxx indicates the cause of the plot error.

    Plot errors occur when there is no data in the file
    or when the data is either out of range or in
    incorrect order.

ERROR MESSAGE	CAUSE	PROGRAM RESP&ONSE
Plot Error 0000	No data in file	Terminates run and returns control to operating system.
Plot Error 0001	No positive X data in file	Terminates run and returns control to operating system.
Plot Error 0002	Data out of order	Data ignored and run continues*
Plot Error 0003	X value out of range	Data ignored and run continues*
Plot Error 0004	Y value out of range	Data ignored and run continues*

The operator should check logical unit assignments. Failure
to assign a physical address to logical unit A produces
PLOT ERROR 0000. Assigning meaningless files to logical
unit A or logical unit 9 will cause many error messages.

* After 20 PLOT ERRORS the run is terminated and control
   returned to the operating system.

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16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

A description is given of Dataplot 70, a program which enables plotting 1) lines between pairs of X-Y coordinates and 2) a string of ASCII characters at a given X-Y coordinate on the electrostatic printer/plotter. Detailed instructions are provided enabling the user to 1) convert data to plotter format, 2) draw axis, 3) label axis, 4) scale data, 5) handle arrays, 6) produce symbols at end points, and 7) offset the origin. Hardware and software requirements as well as loading and operating instructions are given.

A sample FORTRAN calling program is included and each instruction is explained in detail. The output of the calling program is shown. Error messages produced by Dataplot 70 are explained.

17. KEY WORDS (six to twelve entries; alphabetical order; capitalize only the first letter of the first key word unless a proper name; separated by semicolons)

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